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Williamson

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(54) **GENERATING ACTIVE LINKS BETWEEN MODEL OBJECTS**

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G06F 17/30 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 17/30014*** (2013.01)

(58) **Field of Classification Search**
USPC 703/2; 705/35; 707/770
See application file for complete search history.

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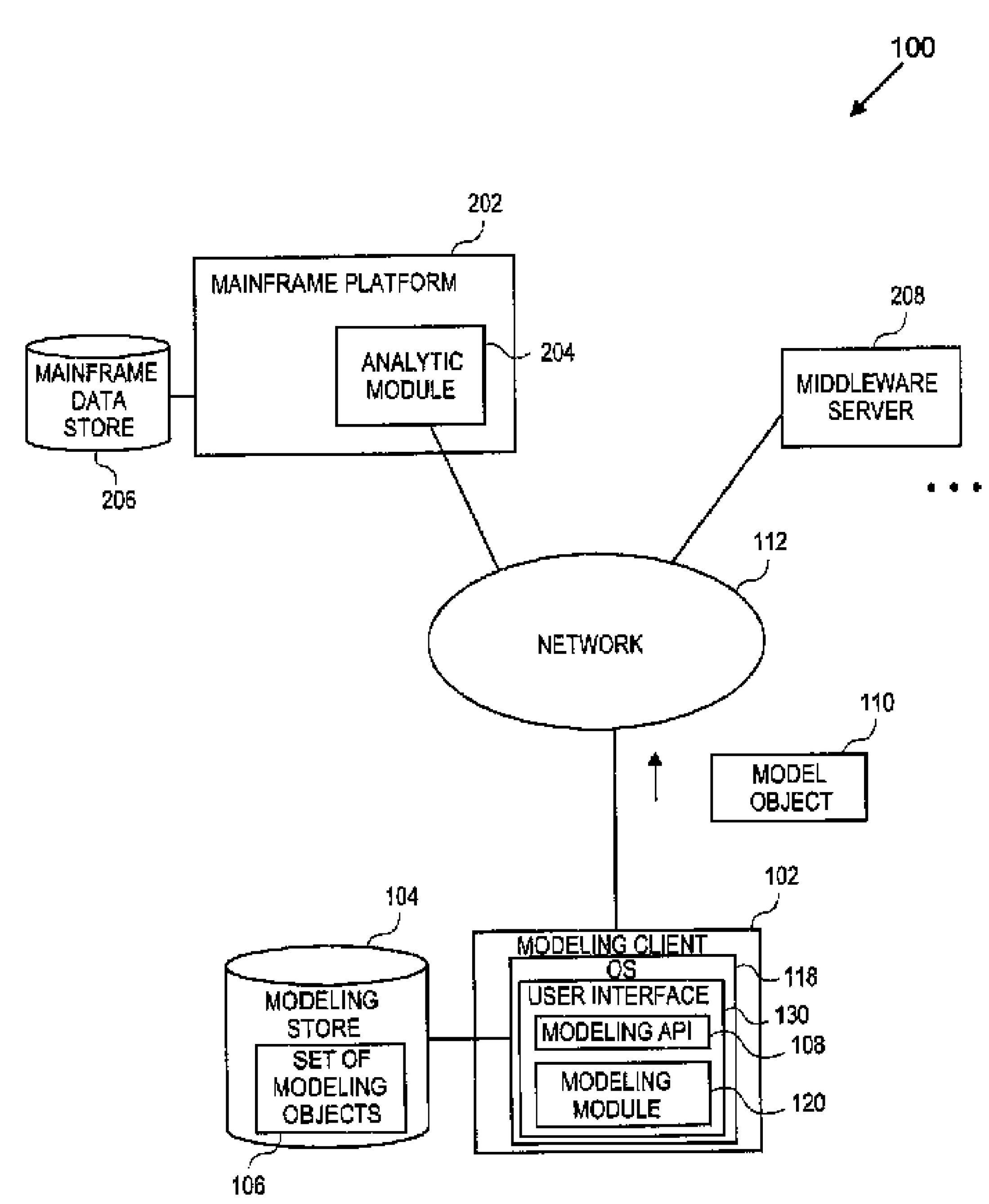
(57) **ABSTRACT**

Embodiments relate to generating active links between model objects. A modeling client can host modeling logic and an application programming interface (API) to create, access, manipulate, and import/export modeling objects used in modeling applications, such as engineering, medical, financial, and other modeling platforms. The source data accepted into the modeling client can include consumer or business-level applications, whose spreadsheet, database or other content can be extracted and encapsulated in object-oriented format, such as extensible markup language (XML) format. Links can be inserted in the resulting model object to link to external resources, such as additional model objects, services, local or remote modeling tools, or other resources. The model object can share, exchange, or combine data from other model object (s), as well as instantiate functions hosted in other model object(s). Multiple links can be inserted to multiple model objects in linked list, node, or other configurations.

23 Claims, 6 Drawing Sheets



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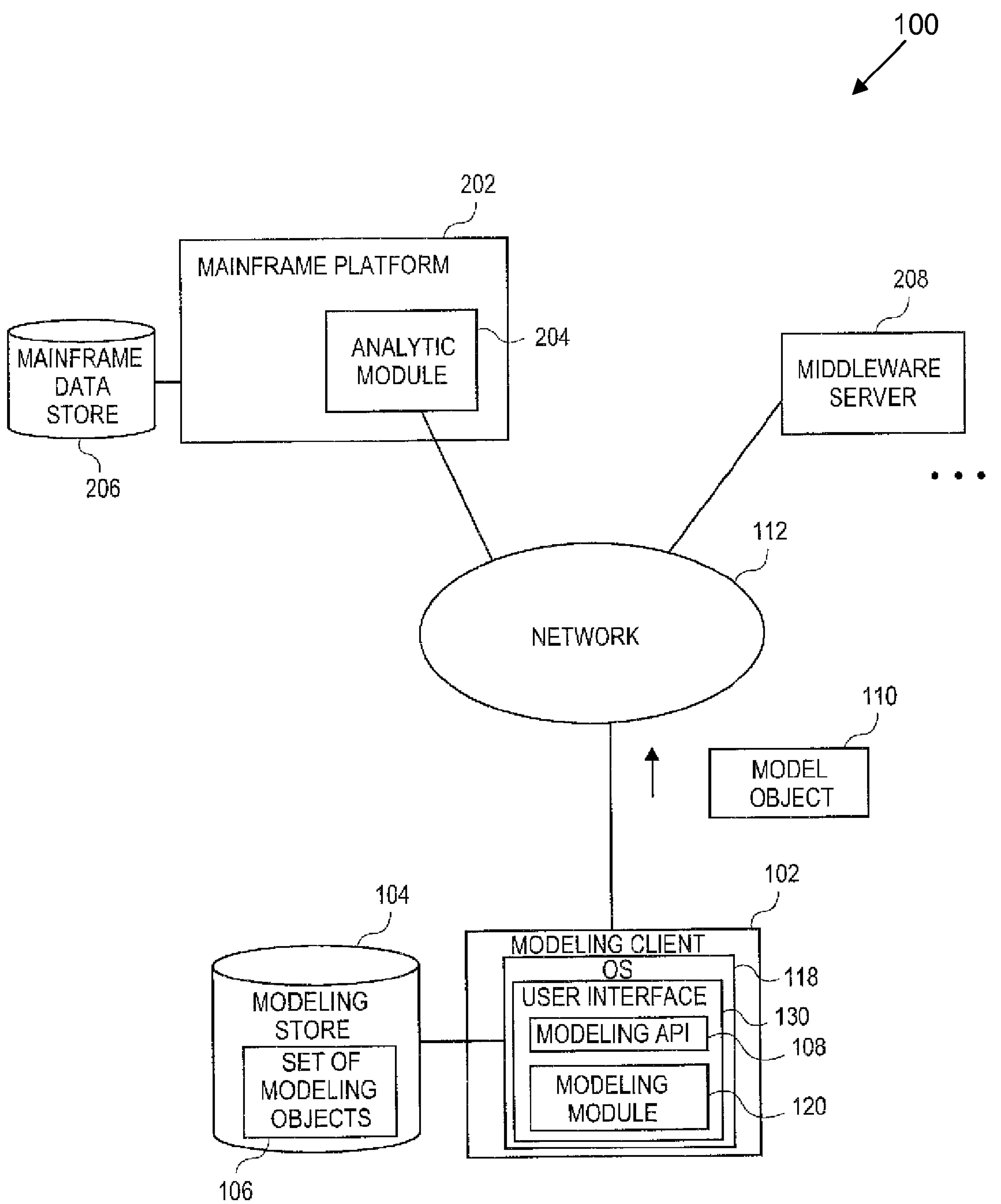
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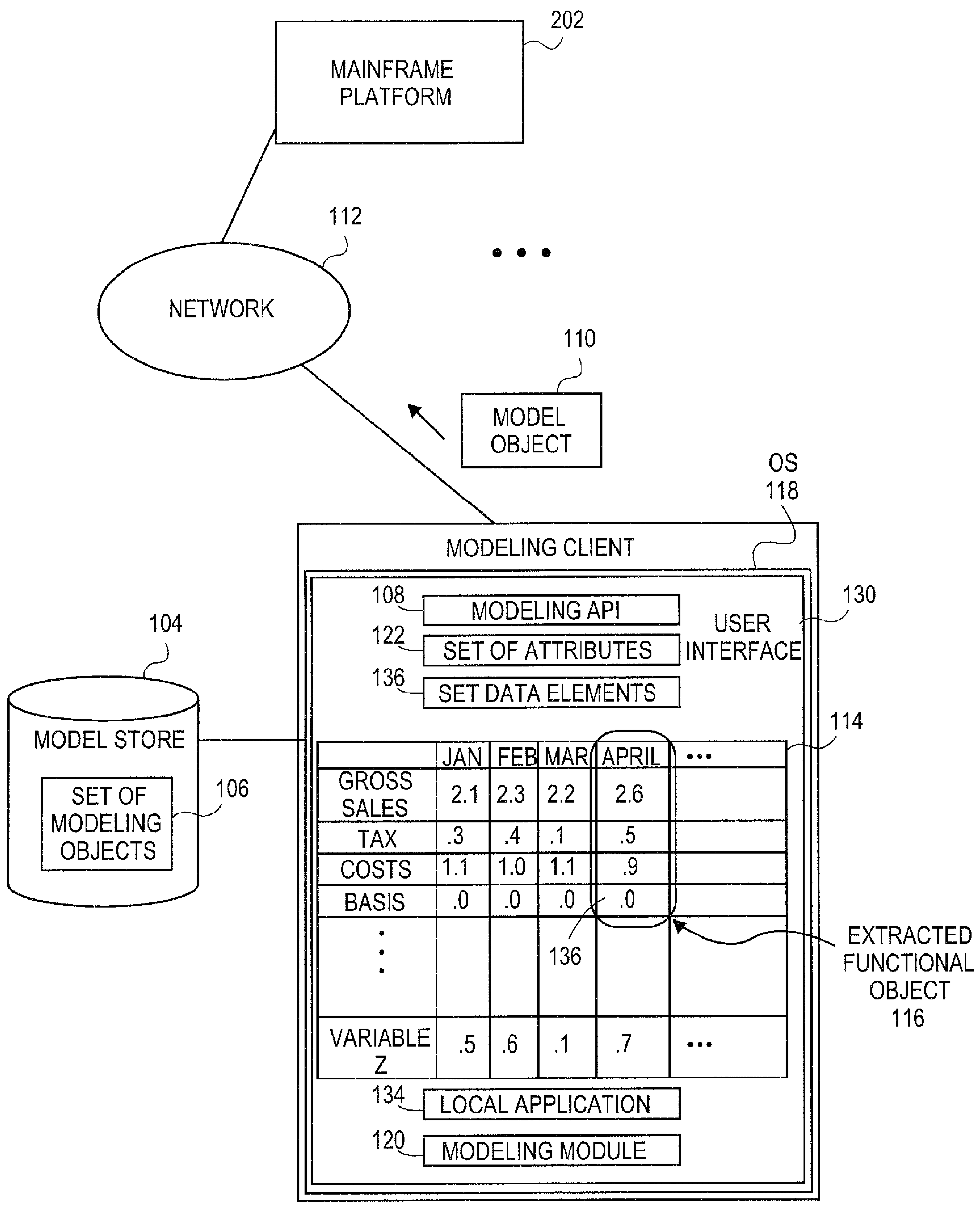
202
MAINFRAME PLATFORM
ANALYTIC MODULE
204
MAINFRAME DATA STORE
206
208
MIDDLEWARE SERVER
112
NETWORK
110
MODEL OBJECT
102
104
MODELING STORE
SET OF MODELING OBJECTS
106
MODELING CLIENT
OS
USER INTERFACE
MODELING API
MODELING MODULE
118
130
108
120

FIG. 1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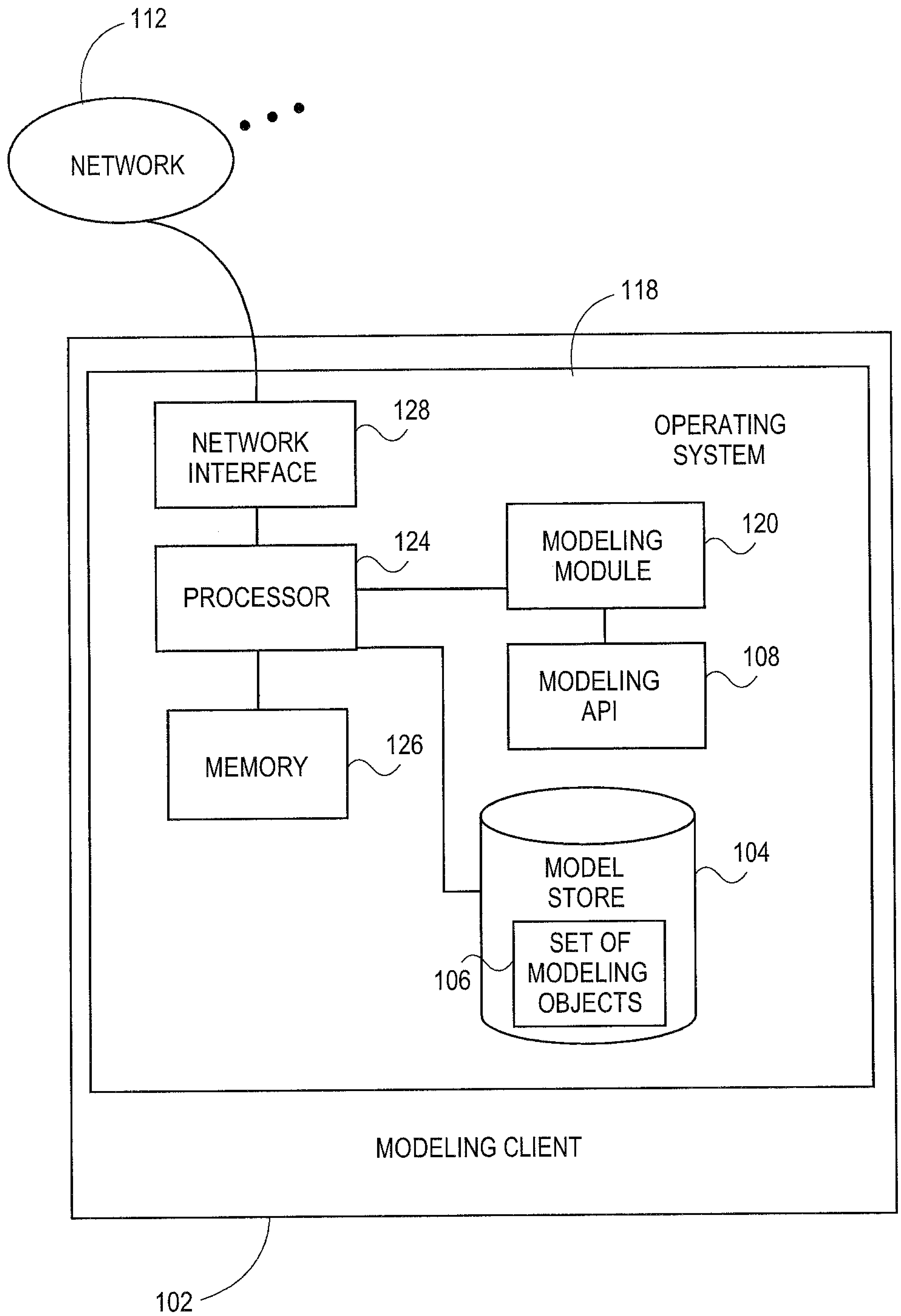
MODELING CLIENT
104
MODEL STORE
SET OF MODELING OBJECTS
106
108
MODELING API
122
SET OF ATTRIBUTES
136
SET DATA ELEMENTS
USER INTERFACE
130
114
JAN FEB MAR APRIL
GROSS SALES 2.1 2.3 2.2 2.6
TAX .3 .4 .1 .5
COSTS 1.1 1.0 1.1 .9
BASIS .0 .0 .0 .0
136
VARIABLE Z .5 .6 .1 .7
EXTRACTED FUNCTIONAL OBJECT 116
134
LOCAL APPLICATION
120
MODELING MODULE

FIG. 2



112
NETWORK
118
128
NETWORK INTERFACE
OPERATING SYSTEM
124
PROCESSOR
MODELING MODULE
120
MODELING API
108
MEMORY
126
MODEL STORE
104
SET OF MODELING OBJECTS
106
MODELING CLIENT
102

FIG. 3

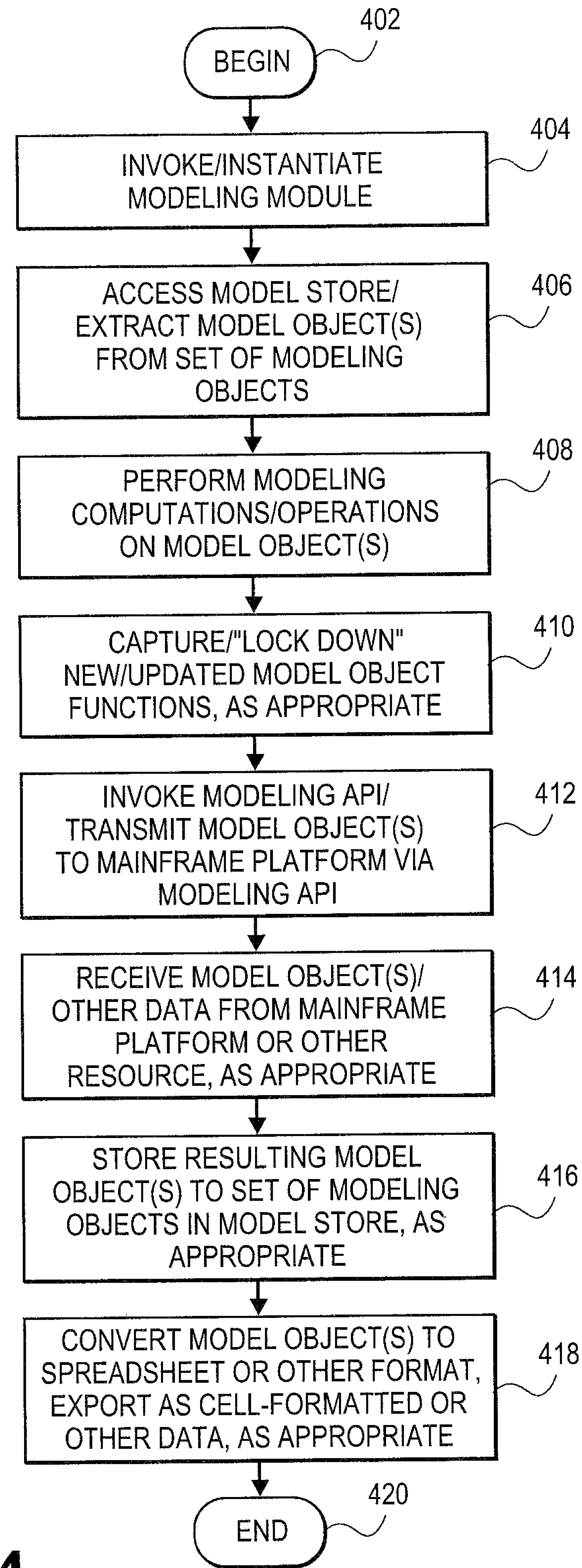
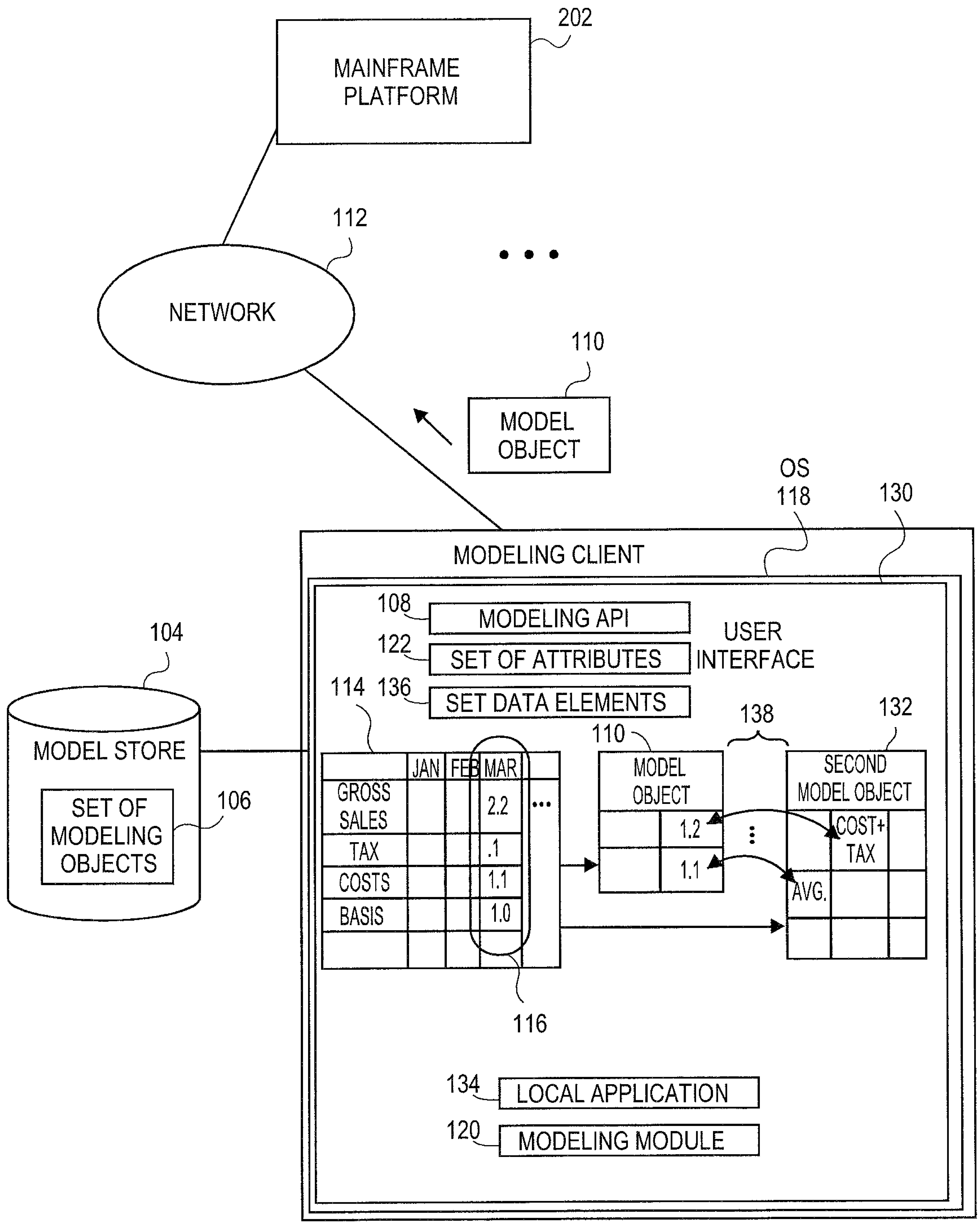

BEGIN
402
INVOKE/INSTANTIATE MODELING MODULE
404
ACCESS MODEL STORE/ EXTRACT MODEL OBJECT(S) FROM SET OF MODELING OBJECTS
406
PERFORM MODELING COMPUTATIONS/OPERATIONS ON MODEL OBJECT(S)
408
CAPTURE/"LOCK DOWN" NEW/UPDATED MODEL OBJECT FUNCTIONS, AS APPROPRIATE
410
INVOKE MODELING API/ TRANSMIT MODEL OBJECT(S) TO MAINFRAME PLATFORM VIA MODELING API
412
RECEIVE MODEL OBJECT(S)/ OTHER DATA FROM MAINFRAME PLATFORM OR OTHER RESOURCE, AS APPROPRIATE
414
STORE RESULTING MODEL OBJECT(S) TO SET OF MODELING OBJECTS IN MODEL STORE, AS APPROPRIATE
416
CONVERT MODEL OBJECT(S) TO SPREADSHEET OR OTHER FORMAT, EXPORT AS CELL-FORMATTED OR OTHER DATA, AS APPROPRIATE
418
END
420

FIG. 4


MAINFRAME PLATFORM
202
NETWORK
112
MODEL OBJECT
110
OS 118
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MODELING CLIENT
108
MODELING API
122
SET OF ATTRIBUTES
USER INTERFACE
114
136
SET DATA ELEMENTS
104
MODEL STORE
SET OF MODELING OBJECTS
106
JAN
FEB
MAR
GROSS SALES
2.2
TAX
.1
COSTS
1.1
BASIS
1.0
116
110
MODEL OBJECT
1.2
1.1
138
132
SECOND MODEL OBJECT
COST+ TAX
AVG.
134
LOCAL APPLICATION
120
MODELING MODULE

FIG. 5

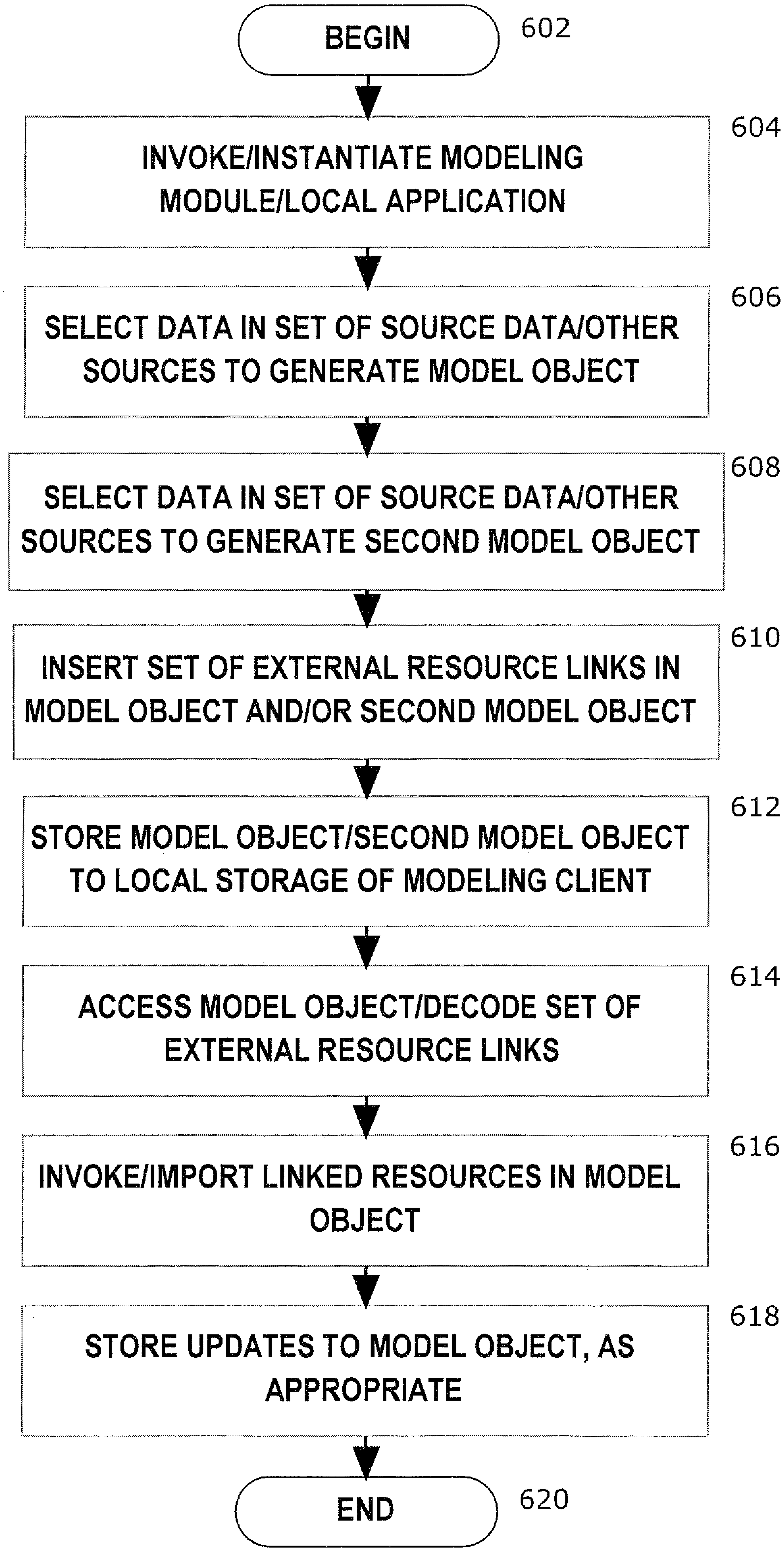
BEGIN
602
INVOKE/INSTANTIATE MODELING MODULE/LOCAL APPLICATION
604
SELECT DATA IN SET OF SOURCE DATA/OTHER SOURCES TO GENERATE MODEL OBJECT
606
SELECT DATA IN SET OF SOURCE DATA/OTHER SOURCES TO GENERATE SECOND MODEL OBJECT
608
INSERT SET OF EXTERNAL RESOURCE LINKS IN MODEL OBJECT AND/OR SECOND MODEL OBJECT
610
STORE MODEL OBJECT/SECOND MODEL OBJECT TO LOCAL STORAGE OF MODELING CLIENT
612
ACCESS MODEL OBJECT/DECODE SET OF EXTERNAL RESOURCE LINKS
614
INVOKE/IMPORT LINKED RESOURCES IN MODEL OBJECT
616
STORE UPDATES TO MODEL OBJECT, AS APPROPRIATE
618
END
620

FIG. 6

GENERATING ACTIVE LINKS BETWEEN MODEL OBJECTS

FIELD

The present teachings relate to systems and methods for generating active links between model objects, and more particularly to platforms and techniques for dedicated modeling of technical, medical, financial, and other systems which are configured to generate model objects and active linkages between those model objects to share data, functions, and other attributes.

BACKGROUND OF RELATED ART

A spectrum of modeling platforms and options exist today for engineers, managers, developers and other professionals. In the case of engineering, medical, technical, financial, and other advanced modeling resources, a range of platforms are available for users interested in setting up, running and maintaining financial modeling systems. For example, organizations interested in relatively sophisticated modeling applications, such as geophysical models for detecting oil reserves or other geologic features or equity market analysis based on Black-Sholes option pricing models, a company or other organization may choose to install advanced modeling software on mainframe-class computers to run those classes of models and obtain various projections, reports, and other results. Such mainframe platform, data center and related installations, however, can involve costs on the order of millions of dollars or more, and may require the full time attention of highly skilled professionals, including programmers and managers with advanced training. As a consequence, putting a mainframe-based modeling operation into place may not be practical or possible for many organizations or users.

On the other end of the spectrum, managers, engineers and others may employ widely available entry-level applications to capture operational data and attempt to develop predictive models for engineering, financial, medial, and other applications. That class of applications can include, for example, consumer or business-level spreadsheet, database, or data visualization programs for technical, financial, and other purposes. For instance, a manager of a manufacturing facility may use a commercially available spreadsheet application to enter production numbers, schedules, and other details of that site. However, attempting to extract useful modeling outputs from those classes of applications can be difficult or impossible. For one, spreadsheet, database, and other widely available applications are typically built to produce reports based on already existing data, but not to generate modeling outputs or objects that represent predictive outputs or scenarios. For another, existing spreadsheet, database, and other applications typically involve limitations on cell size, number of dimensions, overall storage capacity, and other program parameters which, in the case of large-scale modeling operations, may be insufficient to operate on the data sets necessary to produce and run meaningful models.

For another, the data structures and outputs of existing spreadsheet, database and other entry-level or commonly available applications are typically arranged in proprietary format, rather than a widely interoperable object-based or other universal format. As still another drawback, the cells, rows, columns, and other data elements within commonly available spreadsheets, databases, and other entry-level programs can not be extracted as separate units and exported to other modeling or analytic tools. In short, the use of spreadsheet, database, and other consumer or business-level applications to conduct modeling operations involves significant shortcomings, due in part to the fact that those classes of platforms are not designed to reliable handle modeling functionality. At present, therefore, a manager, developer, engineer, or other professional or user with modeling requirements is faced with a choice between installing a large and expensive mainframe-based solution with its attendant infrastructure, a spreadsheet or database-based entry level solution with its attendant limitations on power and data handling, or a combination of those two types of platforms. It may be desirable to provide object-based or object-compatible modeling platforms capable of generating modeling objects which encapsulate various modeling features, and whose content is linkable via active links to exchange or share data, functions, or other attributes.

DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present teachings and together with the description, serve to explain the principles of the present teachings. In the figures:

FIG. **1** illustrates an overall system for a modeling network including various hardware and connectivity resources that can be used in systems and methods for generating active links between model objects, according to various embodiments of the present teachings;

FIG. **2** illustrates an exemplary modeling network including a modeling server and connectivity resources, according to various embodiments;

FIG. **3** illustrates an exemplary hardware configuration for a modeling server that can be used in systems and methods for generating active links between model objects, according to various embodiments;

FIG. **4** illustrates a flow diagram of overall modeling processing for object-based modeling that can be used in systems and methods for generating active links between model objects, according to various embodiments;

FIG. **5** illustrates exemplary operations to generate modeling objects that can contain links to other objects or other external resources, according to various embodiments; and

FIG. **6** illustrates a flow diagram of processing to generate modeling model objects having links to other objects or other external resources, according to various embodiments.

DESCRIPTION OF EMBODIMENTS

Embodiments of the present teachings relate to systems and methods for generating active links between model objects. More particularly, embodiments relate to platforms and techniques that can access, extract, and generate modeling objects in a native object-based or object-compatible format. The modeling objects produced via a modeling client or other modeling tool according to the present teachings can encapsulate both source data describing a physical, medical, technical, financial, or other process or phenomena, and modeling attributes that relate the source data to predictive scenarios, specific models, and other features. In embodiments, the modeling objects can be extracted or "lifted" from data sources such as database programs or others, and stored to local storage of a local modeling client. The model objects can include links to resources that are external to the respective objects, including other model objects. The linked model objects can thereby access, share, and exchange data elements as well as functions, procedures, and other processes or services. The linked model objects can be made visible or available via the desktop or other user interface of the modeling client. These and other embodiments described herein address the various noted shortcomings in known modeling technology, and provide a user or operator with enhanced modeling power on a desktop or other client, allowing direct extraction and manipulation of database dimensions as independent object-based entities. Systems and methods according to the present teachings also allowing seamless generation, local storage, and communication of model objects to backend mainframe platforms, data centers, middleware servers, other modeling clients, and/or other local or remote modeling, storage, or data processing resources.

Reference will now be made in detail to exemplary embodiments of the present teachings, which are illustrated in the accompanying drawings. Where possible the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. **1** illustrates an overall network **100** in which systems and methods for generating active links between model objects can be implemented, consistent with various embodiments of the present teachings. In embodiments as shown, a modeling client **102** can communicate with a variety of local and remote resources, including an mainframe platform **202** via one or more network **112**. Client **102** can be or include, for instance, a personal computer, a server, a dedicated workstation, a mobile device, or other machine, device, hardware, or resource. One or more network **112** can be or include, for example, the Internet, a virtual private network (VPN), a local area network such as an Ethernet network, or other public or private network or networks. Mainframe platform **202** can be or include commercially available platforms or installations, such as, merely for example, mainframe or enterprise platforms available from SAP Inc. of Walldorf, Germany, and other sources.

Mainframe platform **202** can include modules, logic, and functionality to perform an array of computation and data storage tasks, including data warehousing, data mining, statistical analyses, financial planning, inventory management, customer resource management, engineering design, and other applications. In implementations as shown, mainframe platform **202** can host or communicate with a variety or resources including, merely illustratively, a mainframe data store **206**, and logic or applications including an analytic module **204**. Mainframe platform **202** can contain, host, support, or interface to other data processing hardware, software, and other resources. In embodiments, modeling client **102** can likewise communicate with other local or remote resources, such as a middleware server **208** hosting or interfacing to a set of data stores for online analytical processing (OLAP) or other functions. Modeling client **102** can also communicate or interface with other local or remote servers, services, data stores, or other resources.

In embodiments as shown, modeling client **102** can operate under an operating system **118**, such as a distribution of the LInuX™, Unix™, or other open source or proprietary operating system. Modeling client **102** can present a user interface **130**, such as a graphical user interface or command line interface, operating under operating system **118** to receive commands and inputs from a user, and operate modeling client **102**. Modeling client **102** can communicate with storage resources including a modeling store **104**, such as a local or remote database or data store. Modeling store **104** can store a set of modeling objects **106**, in which data, functions, procedures, attributes, and/or other information related to one or more modeling object **110** can be encapsulated and stored. In embodiments, modeling object **110** can be encoded in extensible markup language (XML) format. In embodiments, modeling object **110** can be encoded in other object-based or object-compatible formats or data structures. Modeling client **102** can communicate with mainframe platform **102** via a modeling application programming interface (API) **108**. Modeling application programming interface (API) **108** can include, for instance, defined function calls or calls to other routines, calculations, or features, as well as data structures and parameters associated with modeling operations. For example, modeling application programming interface (API) **108** can include a function call to invoke a Monte Carlo simulation model based on a set of supplied data, such as an identified set of dimensions extracted from a spreadsheet or database. Other functions, routines, resources, and features can be called, invoked, or instantiated via modeling application programming interface (API) **108**. According to embodiments in various regards, one or more local or remote modeling packages, modules, or other supporting applications can be instantiated via modeling module **120** and modeling application programming interface (API) **108** to manipulate source data and resulting one or more modeling object **110**.

In embodiments, a user of modeling client **102** can access, modify, or add data modeling objects to a set of data modeling object **106** via a modeling module **120** hosted in modeling client **102**. Set of data modeling objects **106** can include data objects that the user of modeling client **102** has directly entered, or, in aspects, which the user of modeling client has imported or extracted from sources such as consumer or business-level spreadsheet, database, and/or other applications or platforms. Modeling module **120** can itself be or include applications, software modules or hardware modules, or other logic or resources to operate on set of modeling objects **106**. Modeling module **120** can, merely illustratively, include or access logic or modules for invoking and manipulating a variety of scientific, technical, engineering, medical, financial, manufacturing, or other modeling operations. For instance, modeling module **120** can be or include applications or logic for performing Monte Carlo simulations, finite element analyses, Black-Scholes option pricing or other market analyses, epidemiological projections, geophysical models or simulations, or other simulations, models, trend mappings, projections, or other predictive processes. In embodiments in one regard, after invoking modeling module **120** and performing any modeling task, the user of modeling client **102** can locally store and/or export one or more modeling object **110** to external platforms or resources.

In embodiments as shown, the user of modeling client **102** can for instance export or communicate one or more modeling object **110** to mainframe platform **202** via modeling application programming interface (API) **108**, for storage and use at a local or remote location from within that platform. In aspects, mainframe platform **202** can receive modeling object **110** directly, without a necessity for translation, re-formatting, or invoking any spreadsheet, database, or other application from which data encapsulated in one or mode modeling object **110** originated. In aspects, mainframe platform **202** can operate on one or more modeling object **110**, and transmit or return that data or other results to modeling client **102** via modeling application programming interface (API) **108**. Thus, according to aspects of the present teachings, modeling objects can be exchanged directly and programmatically between modeling client **102**, mainframe platform **202** or other larger-scale or remote platforms, including for instance middleware server **208** or other comparatively large-scale or higher-capacity modeling or analytic tools.

In terms of operating on source data and generating one or more modeling object **110** for local storage and/or exchange with mainframe platform **202** or other platforms, and as shown for instance in FIG. **2**, according to various embodiments, a user of modeling client **102** can invoke modeling module **120** to manipulate a set of source data **114** to identify, configure, and/or extract the functional objects, attributes, or other features of a set of data to produce a modeling output. In embodiments as shown, modeling module **120** can access a set of source data **114**, from which data, attributes, and/or other metadata can be extracted to generate one or more modeling object **110**. In aspects, set of source data **114** can be generated, hosted, or stored by or in a local application **134**, such as a spreadsheet, database, accounting, word processing, presentation, or other application or software. In aspects, set of source data **114** can comprise data previously or newly generated in the form of an object-based modeling object, such as a modeling object entered, imported, or specified by the user of modeling client **102**. In aspects, set of source data **114** can comprise data originally stored or generated in a consumer or business-level spreadsheet, database, and/or other application or software. In aspects, set of source data **114** can be initially formatted or encoded in a non-object oriented format, such as in a cellular array or in a relational database format. In aspects, set of source data **114** can be initially formatted or encoded in an object-oriented format, such as extensible markup language (XML) format. In aspects, a user of modeling client **102** can highlight, select, or otherwise specify all or a portion of set of source data **114** to generate one or more extracted functional object **116**. For instance, a user can highlight a column of set of source data **114** to identify and extract data as well as functional relationships of interest, to the user, as a unified object. Thus, purely illustratively and as shown, a user may wish to obtain a view on a current month's sales figures including gross sales, tax, production or delivery costs, and cost basis, as well as other parameters related to sales activity. In aspects as shown, a user can, for instance, highlight those functional relationships by dragging a cursor or otherwise selecting a set of cells to group together, and form one or more extracted functional object **116**. In aspects, selection can include the extraction of set of data elements **136**, such as values stored in spreadsheet cells or database entries. In aspects, once a set of data elements **136** are selected, the functional, computational, or other modeling parameters associated with that data can be stored or associated with one or more extracted functional object **116**. For instance, modeling module **120** can store associated routines, computations, processes, or other attributes or functional specifications for one or more extracted functional object **116** in set of attributes **122**, which can be stored or associated with one or more extracted functional object **116**. In aspects, set of attributes **122** can include the identification of or linkage to any routines, interfaces, or other functional or computational resources that will be associated with one or more extracted functional object. According to various embodiments, analytic module **204** of mainframe platform **202**, or other resource or platform receiving one or more extracted functional object **116** from modeling client **102** can thereby obtain both data values derived or obtained from set of source data **114**, as well as functional or procedural resources and relationships associated with that data. One or more extracted functional object **116** along with any associated set of attributes **122** can be encoded or stored in one or more modeling object **110**, which can thereby be transparently exported to mainframe platform **202**, middleware server **208**, or other platforms or destinations for further modeling operations.

FIG. **3** illustrates an exemplary diagram of hardware, software, connectivity, and other resources that can be incorporated in a modeling client **102** configured to communicate with one or more network **112**, including to interface with mainframe platform **202**, middleware server **208**, and/or other local or remote resources. In embodiments as shown, modeling client **102** can comprise a processor **124** communicating with memory **126**, such as electronic random access memory, operating under control of or in conjunction with operating system **118**. Operating system **118** can be, for example, a distribution of the Linux™ operating system, the Unix™ operating system, or other open-source or proprietary operating system or platform. Processor **124** also communicates with a model store **104**, such as a database stored on a local hard drive, which may store or host set of modeling objects **106**. Processor **124** further communicates with network interface **128**, such as an Ethernet or wireless data connection, which in turn communicates with one or more networks **112**, such as the Internet, or other public or private networks. Processor **124** also communicates with modeling module **120** along with modeling application programming interface (API) **108** and/or other resources or logic, to execute control and perform modeling calculation, translation, data exchange, and other processes described herein. Other configurations of the network modeling client **102**, associated network connections, and other hardware and software resources are possible. While FIG. **3** illustrates modeling client **102** as a standalone system comprises a combination of hardware and software, modeling client **102** can also be implemented as a software application or program capable of being executed by a conventional computer platform. Likewise, modeling client **102** can also be implemented as a software module or program module capable of being incorporated in other software applications and programs. In either case, modeling client **102** can be implemented in any type of conventional proprietary or open-source computer language.

FIG. **4** illustrates a flow diagram of overall processing that can be used in systems and methods for generating active links between model objects, according to various embodiments. In **402**, processing can begin. In **404**, a user of modeling client **102** or other client or device can invoke or instantiate modeling module **120** or other logic, to perform modeling operations. In **406**, modeling module **120** can access model store **104** and extract one or more modeling object **110** from set of modeling objects **106**. In **408**, modeling computations or other operations can be performed on one or more modeling object **110**. For example, a modeling operation can be performed to project or predict the output of a factory based on various supply scenarios for parts, materials, energy costs, or other variables. In **410**, the values, functions, linkages, or other attributes of one or more data modeling object **110** that were accessed, produced, or modified by the modeling operations can be captured, fixed, or locked down by modeling module **120**. For instance, the resulting one or more modeling object **110** can be stored to set of modeling objects **106** in model store **104**, or other databases or data stores.

In **412**, modeling application programming interface (API) **108** can be invoked by modeling module **120**, by mainframe platform **202**, or other resources to transfer one or mode modeling object **110** to mainframe platform **202**. In embodiments, one or more modeling object **110** can for instance be communicated to mainframe platform **202** via a secure connection or channel, such as a secure socket layer (SSL) connection, via a channel encrypted using a public/private key infrastructure, or other channel or connection. In **414**, one or more model object **110** can be received in modeling module **120** from mainframe platform **202** or other resource, as appropriate. For example, an updated version of one or more model object **110** reflecting new data, new modeling results, or other information can be received in modeling module **120**. In **416**, the resulting new, updated, or modified one or more model object **110** can be stored to set of modeling objects **106** in model store **104**, as appropriate. In embodiments, one or more model objects **110** can in addition or instead be stored to mainframe data store **206**, to middleware server **208**, to another modeling client or other client, or other site or destination. in **418**, modeling module **120** can convert one or more model objects **110** to spreadsheet, database, or other format, and export any converted data as a set of cell-formatted information, or data encoded in other formats. For instance, modeling module **120** can convert or translate one or more model objects to cell data values or database entries, and export that data to client-level applications on modeling client **102** or other local or remote devices or storage. In **420**, processing can repeat, return to a prior processing point, jump to a further processing point, or end.

According to various embodiments of the present teachings, and as for example generally illustrated in FIG. **5**, in implementations modeling module **120** can generate modeling objects by operating on one or more set of source data **114**, to create a model object and a second model object **132**, for instance using techniques described herein. In aspects, model object **110** can include a set of external resource links **138** external to the object, such as hyperlinks or other links, pointers, or identifiers. In embodiments, each link in set of external resource links **138** can specify or identify one or more resources to which a model object, such as model object **110**, can link, connect, communicate, or otherwise interact, including other one or more additional model objects, data fields or functions in those additional model objects, services, Web sites, applications, and/or other resources. In embodiments, modeling module **120** can insert set of external resource links **138** as information in set of attributes **122** associated with model object **110**, second model object **132**, and/or other objects or entities.

In embodiments, the linkage identified in set of external resource links **138** can link to second model object **132**, and for instance specify that a data element located in a certain location of second model object **132** be automatically imported into a corresponding cell, field, or other site of model object **110**, for instance whenever the data element populating second model object **132** at that site is updated. In embodiments, functions or other procedures or calls can be imported from second model object **132** to model object **110**. In embodiments, set of external resource links **138** can contain links or mappings from one data element or function to multiple data fields, elements or functions of different model objects, from multiple data fields, elements or function to multiple data elements or functions, from multiple data fields, elements or functions to a single data element or function, or other configurations. In embodiments, two or more model objects can be linked via set of external resource links **138** in a chain, tree, node, web, or other configurations.

In embodiments in various regards, once model object **110**, second model object **132**, and any other objects are extracted, modeling module **120** can capture and store, or lock down, the data elements or content of those objects along with any attributes or other metadata, including set of external resource links **138**, in or in association with each modeling object. In embodiments, model object **110**, second model object **132**, and others so generated can be stored in model store **104**, or other local storage of modeling client **102**. In embodiments as shown, therefore, model object **110** and second model object **132** can reside on modeling client **102**, and any one or more of the resources linked between those objects or other resources can be seamlessly shared on modeling client **102**. It may be noted that while each of model object **110** and second model object **132** can be stored or hosted in modeling client **102**, in embodiments, either of model object **110**, second model object **132**, and other objects can also or instead be hosted or stored in other local or remote platforms, such as mainframe platform **202**, middleware servers, other modeling or other clients, or other destinations.

FIG. **6** illustrates a flow diagram of overall processing to generate and manipulate one or more model object **110** having links to additional model objects or other external resources, according to various embodiments. In **602**, processing can begin, In **604**, a user can invoke or initiate modeling module **120** and/or local application **134**, such as, for instance, a spreadsheet application, a database application, or other applications or software. In **606**, the user can select data in set of source data **114** or other data sources to generate a model object **110**, including related data elements and attributes. In **608**, the user can select data in set of source data **114** or other data sources to generate second model object **132**, including related data elements and attributes for that object.

In **610**, the user can insert a set of external resource links **138** in either of model object **110** and/or second model object **132**, for instance, by highlighting desired data elements, functions, or other information in each object, and selecting a linkage type (e.g., hyperlink, pointer, one-way link, two-way link, or other linkage) or other mapping between the objects. In aspects, multiple linkages between elements or functions of either model object **110** and/or second model object **132** can be established. In **612**, modeling module **120** can store model object **110** and/or second model object **132** to local storage of modeling client **102**, such as model store **104** or other local storage, as appropriate. In **614**, modeling module **120** can access model object **110**, and decode set of external resource links **138** to identify second model object **132** or other external resources to associate and link with model object **110**. In **616**, modeling module **120** can invoke and import, receive, update, or otherwise process the data, functions, or other resources so linked to model object **110**, such as, for instance, to automatically import any updated data from certain sections of second model object **132** (e.g., columns **2** and **3**), or call a function or routine specified by a cell (e.g., cell) of second model object **132**. In **618**, any updates to model object **110** can be stored to model store **104** or other storage, as appropriate. In **620**, processing can repeat, return to a prior processing point, jump to a further processing point, or end.

The foregoing description is illustrative, and variations in configuration and implementation may occur to persons skilled in the art. For example, while embodiments have been described wherein one or more model object **110** is accessed and manipulated via one modeling client **102**, in embodiments, one or more users can use multiple modeling clients, or networks including modeling clients or other resources, to operate on model object data. For further example, while embodiments have been described in which modeling client **102** may interact with one mainframe platform **202** and/or one middleware server **208**, in embodiments, one or more modeling client **102** can interact with multiple mainframe platforms, data centers, middleware servers, and/or other resources, in various combinations. Yet further, while embodiments have been described in which a modeling client **102** interacts with a mainframe platform **202** and/or middleware server **208**, in embodiments, rather than interact with large-scale mainframe platforms, data centers, or middleware servers, modeling client **102** can interact with other local or remote modeling clients, networks of those clients, or, in embodiments, can operate to perform modeling operations on a stand-alone basis, without necessarily communicating with other modeling platforms. Other resources described as singular or integrated can in embodiments be plural or distributed, and resources described as multiple or distributed can in embodiments be combined. The scope of the present teachings is accordingly intended to be limited only by the following claims.

What is claimed is:

1. A method comprising:

invoking an application, the application comprising source data, wherein the source data comprises a cellular array format;

encapsulating a first set of cells of the source data in a first predictive model object, wherein a modeling application performs an operation on the first predictive model object to predict an output, and wherein the first predictive model object is encoded in extensible markup language (XML) format;

encapsulating a second set of cells of the source data in a second predictive model object, wherein the second predictive model object is encoded in XML format and, a cell of the second set of cells in the second predictive model object specifies a function;

receiving a user selection of a linkage type for an import link, wherein the import link imports the function specified by the cell of the second set of cells in the second predictive model object as a corresponding function in a corresponding cell in the first set of cells in the first predictive model object;

inserting the import link in the first predictive model object in view of the user selection of the linkage type;

changing, by the modeling application, the function specified by the cell of the second set of cells in the second predictive model by performing the operation on the second predictive model object to predict a second output; and

calling, by a client device, the changed function specified by the cell of the second set of cells in the second predictive model object as the corresponding function in the corresponding cell in the first set of cells in the first predictive model object using the import link in response to the function in the second predictive model being changed.

2. The method of claim **1**, further comprising:

storing the first predictive model object and the second predictive model object in storage of the client device.

3. The method of claim **1**, wherein the first predictive model object and the second predictive model object are linked in at least one of a tree, node, or web configuration.

4. The method of claim **1**, wherein the first predictive model object and the second predictive model object comprise an attribute, the attribute comprising at least one of a function call parameter or a linkage parameter.

5. The method of claim **1**, wherein the link comprises a plurality of links.

6. The method of claim **5**, wherein the plurality of links invoke at least one of a plurality of additional predictive model objects, a mainframe modeling platform, or an additional modeling client device.

7. The method of claim **1**, wherein the source data comprises at least one of spreadsheet data, database data, word processing data, or presentation data.

8. The method of claim **1**, where the source data is hosted in at least one of local storage of the client device or remote storage.

9. The method of claim **1**, wherein the operation is a Monte Carlo operation.

10. A client system comprising:

an interface to source data in an application; and

a processor, communicating with the source data via the interface, the processor to:

invoke an application, the application comprising source data, wherein the source data comprises a cellular array format,

encapsulate a first set of cells of the source data in a first predictive model object, wherein a modeling application performs an operation on the first predictive model object to predict an output, and wherein the first predictive model object is encoded in extensible markup language (XML) format,

encapsulate a second set of cells of the source data in a second predictive model object, wherein the second predictive model object is encoded in XML format and, a cell of the second set of cells in the second predictive model object specifies a function,

receive a user selection of a linkage type for an import link, wherein the import link imports the function specified by the cell of the second set of cells in the second predictive model object as a corresponding function in a corresponding cell in the first set of cells in the first predictive model object;

insert the import link in the first predictive model object in view of the user selection of the linkage type,

change, by the modeling application, the function specified by the cell of the second set of cells in the second predictive model by performing the operation on the second predictive model object, and

call the changed function specified by the cell of the second set of cells in the second predictive model object as the corresponding function in the corresponding cell in the first set of cells in the first predictive model object sing the import link in response to the function in the second predictive model being changed.

11. The system of claim **10**, further comprising:

a memory coupled to the processor to store the first predictive model object and the second predictive model object.

12. The system of claim **10**, wherein the first predictive model object and the second predictive model object are linked in at least one of a tree, node, or web configuration.

13. The system of claim **10**, wherein the first predictive model object and the second predictive model object comprise an attribute, the attribute comprising at least one of a function call parameter or a linkage parameter.

14. The system of claim **10**, wherein the link comprises a plurality of links.

15. The system of claim **14**, wherein the plurality of links invoke at least one of a plurality of additional predictive model objects, a mainframe modeling platform, or an additional modeling client system.

16. The system of claim **10**, wherein the source data comprises at least one of spreadsheet data, database data, word processing data, or presentation data.

17. The system of claim **10**, where the source data is hosted in at least one of local storage of the client system or remote storage.

18. The client system of claim **10**, wherein the operation is a Monte Carlo operation.

19. A non-transitory computer system readable medium including instructions that, when executed by a processor, cause the processor to perform operations comprising:

invoking an application, the application comprising source data, wherein the source data comprises a cellular array format;

encapsulating a first set of cells of the source data in a first predictive model object, wherein a modeling application performs an operation on the first predictive model object to predict an output, and wherein the first predictive model object is encoded in extensible markup language (XML) format;

encapsulating a second set of cells of the source data in a second predictive model object, wherein the second predictive model object is encoded in XML format and, a cell of the second set of cells in the second predictive model object specifies a function;

receiving a user selection of a linkage type for an import link, wherein the import link imports the function specified by the cell of the second set of cells in the second predictive model object as a corresponding function in a corresponding cell in the first set of cells in the first predictive model object;

inserting the import link in the first predictive model object in view of the user selection of the linkage type;

changing, by the modeling application, the function specified by the cell of the second set of cells in the second predictive model by performing the operation on the second predictive model object to predict a second output; and

calling, by the processor, the changed function specified by the cell of the second set of cells in the second predictive model object as the corresponding function in the corresponding cell in the first set of cells in the first predictive model object using the import link in response to the function in the second predictive model being changed.

20. The non-transitory computer system readable medium of claim **19**, wherein the first predictive model object and the second predictive model object are linked in at least one of a tree, node, or web configuration.

21. The non-transitory computer system readable medium of claim **19**, wherein the first attribute and the second attribute comprise at least one of a function call parameter or a linkage parameter.

22. The non-transitory computer system readable medium of claim **19**, wherein the link comprises a plurality of links to invoke at least one of a plurality of additional predictive model objects, a mainframe modeling platform, or an additional modeling client device.

23. The non-transitory computer system readable medium of claim of claim **19**, wherein the operation is a Monte Carlo operation.

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